

Depth dose distribution study within a phantom torso after irradiation with a simulated Solar Particle Event at NSRL

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The adequate knowledge of the radiation environment and the doses incurred during a space mission is essential for estimating an astronaut's health risk. The space radiation environment is complex and variable, and exposures inside the spacecraft and the astronaut's body are compounded by the interactions of the primary particles with the atoms of the structural materials and with the body itself. Astronauts' radiation exposures are measured by means of personal dosimetry, but there remains substantial uncertainty associated with the computational extrapolation of skin dose to organ dose, which can lead to over- or under-estimation of the health risk. Comparisons of models to data showed that the astronaut's Effective dose (E) can be predicted to within about a $\pm 10\%$ accuracy using space radiation transport models for galactic cosmic rays (GCR) and trapped radiation behind shielding. However for solar particle event (SPE) with steep energy spectra and for extra-vehicular activities on the surface of the moon where only tissue shielding is present, transport models predict that there are large differences in model assumptions in projecting organ doses. Therefore experimental verification of SPE induced organ doses may be crucial for the design of lunar missions.

In the research experiment "Depth dose distribution study within a phantom torso" at the NASA Space Radiation Laboratory (NSRL) at BNL, Brookhaven, USA the large 1972 SPE spectrum was simulated using seven different proton energies from 50 up to 450 MeV. A phantom torso constructed of natural bones and realistic distributions of human tissue equivalent materials, which is comparable to the torso of the MATROSHKA phantom currently on the ISS, was equipped with a comprehensive set of thermoluminescence detectors and human cells. The detectors are applied to assess the depth dose distribution and radiation transport codes (e.g. GEANT4) are used to assess the radiation field and interactions of the radiation field with the phantom torso. Lymphocyte cells are strategically embedded at selected locations at the skin and internal organs and are processed after irradiation to assess the effects of shielding on the yield of chromosome damage. The initial focus of the present experiment is to correlate biological results with physical dosimetry measurements in the phantom torso. Further on, the results of the passive dosimetry within the anthropomorphic phantoms represent the best tool to generate reliable data to benchmark computational radiation transport models in a radiation field of interest.

The presentation will give first results of the physical dose distribution, the comparison with GEANT4 computer simulations based on a Voxel model of the phantom, and a comparison with the data from the chromosome aberration study.

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